ENGINEERS ESTIMATE

The Engineer's Estimate is an important part of the overall design process. It is a determination of the construction costs for any given project. The estimate is then used for programming and funding proposes. Preparing the estimate requires knowledge of construction methods, fabrication processes and construction costs based on the measurement and payment section in the Specifications. An Engineer's Estimate is required for all projects.

Every item that is called out on the plans shall be included in the estimate. Each item must be paid for in some manner. It shall include the category code number, an item description, unit of measure, quantity, unit cost and total cost for each item. The total cost for each item is then summarized to receive the overall engineer's estimate. For signal, sign, pavement marking, and lighting design, the estimate may include two types of construction items.

- First are items that are furnished by SHA and installed by the contractor.
- Second are items that are furnished and installed, removed or only installed by the contractor.

Examples given in this section refer to equipment being "Furnished and/or Installed by the Contractor" unless otherwise indicated.

It is highly important for the Engineer to know and understand the Engineering Change Notice (ECN) process and the content of a Specification, which can be found in Appendix 9 of this Traffic Control Design Manual. Knowing the ECN process and the hierarchy of Specifications will centralize the Engineer's understanding of how changes in directives, guidelines, standards, specifications, or engineering practices may affect his or her estimates.

Estimating Quantities

The first step in producing an estimate is to calculate the quantities that will be required for the project. Quantities are calculated using the design as shown on the plan sheets. Quantities are measured in various ways. The most common units of measure are cubic yards, linear feet, each, lump sum or square feet. Each quantity shall have a unit of measure. This defines how the item is paid; refer to the Standard Specifications (Blue Book). The specifications and special provisions define how an item is paid for (unit of measurement), what the payment includes and what the payment does not include.

In the material following, various examples of items needed for signing, pavement marking, signals, and lighting are discussed.

Signs

Signs are paid for by the square foot (SF) area of the sign face, including all necessary mounting hardware for ground mounted and overhead signs. This is the same for both sheet and extruded aluminum, however they are paid for as separate items. This is due to the different associated costs. Sign overlays are always constructed from sheet aluminum.

Signs are often furnished by SHA and installed by the contractor for most Areawide Contracts; specifically all signal related signs are furnished by the SHA. It is important to clarify in the early design stages whom will be supplying the signs for a given project.

Available Items	Unit
Sheet Aluminum Signs	Square Feet
Extruded Aluminum Signs	Square Feet
Overlay Overhead Signs	Square Feet
Overlay Ground Mounted Signs	Square Feet

Ground Mounted Sign Supports

Wood and Steel Ground Mounted Supports are paid for by the linear footage of installed support. Where breakaway steel posts are required, there will be one breakaway base support system for each post. For wood supports, the additional modifications are incidental and not measured or paid for. Concrete foundations for steel supports are paid separately based on the sizes listed in the Book of Standards.

The calculation of support length requires the collection of roadside elevations, as discussed in the **Field Review** chapter. As an example, we will look at the following sign:

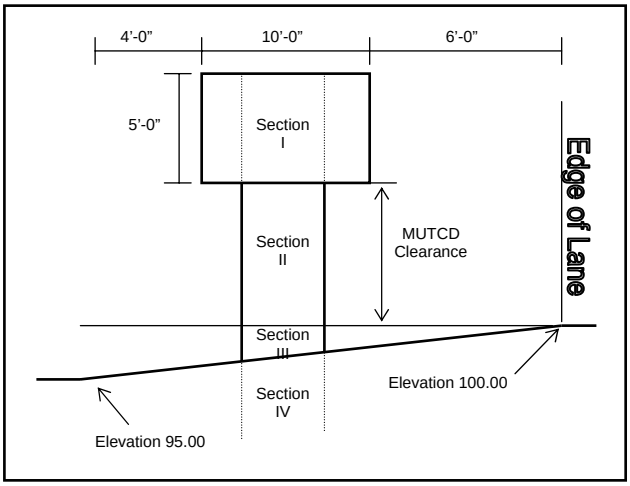

Figure 73 - Ground Mounted Support Lengths

The ground mounted support length can be calculated in four sections, numbered 1 to 4 in the picture above. The support length for each of these sections is determined as follows:

SECTION I: This section equals the sign height. New supports should extend to the top of the sign.

SECTION II: This section is equal to the MUTCD mounting height, 5'-0" for rural areas and 7'-0" in urban areas. This section will usually be 7'-6" for breakaway steel supports.

SECTION III: This section is the additional support length due to the roadside slope. It can be calculated as the overall embankment height (5.00 feet in the above example) times the ratio of support offset to slope length. For the sign shown above, this calculation for the right support would be as follows:

Support offset from top of slope = 6' + $(10')^{1}/_{5}$ = 6 + 2 = 8'-0"Section = $(5.00)\ ^{8}/_{20}$ = 2.00 Feet

SECTION IV: This section is the depth of bury below the ground line for the support. For steel supports, this number is zero (0'-0"). For 4"x4" and 4"x6" wood supports, it is 5'-0" and for 6"x6" and 6"x8" supports it is 6'-0".

The overall height of the right support in the above example would be 5' (sign height) + 7' (mounting height) + 2' (addition for slope) + 5' (assuming 4"x6" wood) = 19'-0". Note that if this example had been for a cut slope, the slope addition would be a negative number.

Another item to be careful of is Aluminum Angles. They are considered incidental hardware and not paid for when used to mount extruded signs to wood supports. They are measured and paid for when used to mount a taller sign to existing steel supports. The angles are used to connect the new panels and provide stiffness that would have come from the supports. They are usually installed in pairs of two, with each angle being twice the height of the sign addition/extension (See Standard 813.05).

Available Items	Unit
Wood Supports (per size)	Linear Feet
Steel Supports (per size)	Linear Feet
Breakaway Base Support System	Each
Concrete for Sign Foundation	Cubic Yards
Aluminum Angle (2½ x 3½ x ¼)	Linear Feet

Overhead Structures

Overhead Supports, both cantilever and overhead structures, are paid for by each structure installed. This number includes anchor bolts, sign supports, and all hardware. Foundations are paid separately based on the size specified on the plans.

Available Items	Unit
Cantilever Sign Structure	Each
Overhead Sign Structure	Each
Concrete for Sign Foundation	Cubic Yards

4" PVC Conduit in Sign Foundation	Linear Feet

Miscellaneous Sign Items

When needed, sheet aluminum signs are used in conjunction with signals to achieve a desired message. They can be mounted on the mast arms, span wire, banded to the signal pole, or installed as a ground mounted sign. Signs may also be banded to overhead structures and light poles.

(Note: Equipment Furnished by SHA)

Available Items	Unit
Hardware for Mast Arm Mount Sign	Each
Hardware for Span Wire Mount Sign	Each
Hardware to Band Sign to Support	Each

Available Items	Unit
Install Span Wire Mount Sign	Square Feet
Install Mast Arm Mount Sign	Square Feet
Band Sign to Support	Each

Depending on the type of installation you are designing, there are other miscellaneous quantities that may be necessary.

Available Items	Unit
Modify Message, Overhead	Each Character
Modify Message, Ground Mounted	Each Character

Sign Removal Items

Whenever the contractor must remove existing signs and supports, items must be included in the estimate. In general, sign removal is paid for by Square Footage (SF), including removal of the supports if specified on the plans. When signs will be removed and relocated, refer to the Special Provision for the appropriate pay items.

Available Items	Unit
Remove Overhead Sign/Luminaire Supports	Each
Remove Overhead Signs	Square Feet
Remove Ground Mounted Signs and Supports	Square Feet
Remove Existing Overhead Structure	Each
Remove Existing Cantilever Structure	Each

Pavement Markings

Lane lines, edge lines, channelizing lines and gore markings are paid for by the linear footage of material installed. Arrow, word and symbol markings are paid for each item installed. When calculating quantities, they should be separated by line width, color, and material (for example 12" White Thermoplastic).

Available Items	Unit
Yellow Paint (5", or 10")	Linear Feet
Yellow Patterned Preformed Tape (5", or 10")	Linear Feet
Yellow Thermoplastic (5", or 10")	Linear Feet
White Paint (5", 10", or 16")	Linear Feet
White Patterned Preformed Tape (5", or 10")	Linear Feet
White Thermoplastic (5", 10", or 16")	Linear Feet
12" White Heat Applied Permanent Preformed Thermoplastic Pavement Marking	Linear Feet
16" White Heat Applied Permanent Preformed Thermoplastic Pavement Marking	Linear Feet
24" White Heat Applied Permanent Preformed Thermoplastic Pavement Marking	Linear Feet
Heat Applied Permanent Preformed Thermoplastic Pavement Marking Letter	Each
Heat Applied Permanent Preformed Thermoplastic Pavement Marking Arrow	Each
Heat Applied Permanent Preformed Thermoplastic Pavement Marking Symbol	Each
Plowable Raised Pavement Markers	Each

* NOTE - see Category Code Book for other pay items.

Signal Cabinet and Controller

The cabinet and controller are items that are furnished by SHA and installed by the contractor. These items are paid for per each. The cabinet also requires a concrete foundation. A Metered Service Pedestal is used to provide the power supply for new cabinets.

(Note: Equipment Furnished by SHA)

Available Items	Unit
Eight Phase Fully Actuated Controller Housed in a NEMA Cabinet – Base Mount (per size of cabinet)	Each
Eight Phase Fully Actuated Controller Housed in a NEMA Cabinet – Pole Mount	Each
Video Interface Equipment	Each
4-Channel Detector Amplifier (Rack Mount)	Each

Available Items	Unit
Concrete for Foundation	Cubic Yards
Electrical Utility Service Equipment	Each
Metered Service Pedestal	Each
Install Controller and Cabinet – Base Mount	Each
Install Controller and Cabinet – Pole Mount	Each
2 Wire Central Control Unit	Each

Signal Structures

Signal structures are paid per each for each size. For example, “Furnish and Install 27’ Steel Pole with 50’ Mast Arm” is a different item than “Furnish and Install 27’ Steel Pole with 60’ Mast Arm”. Signal Structures also require concrete foundations. These items are typically furnished and installed by the contractor. Strain poles require the use of span wire to attach the signals and signs. Span wire is measured per linear foot. This quantity should account for the sag and extra at either end to attach to the strain poles.

Available Items	Unit
Steel Pole with Mast Arm (per size)	Each
Strain Pole (per size)	Each
Breakaway Pedestal Pole (any size)	Each
Cut, Clean, Galvanize and Cap Signal Structure	Each
Concrete for Signal Foundation	Cubic Yards
Steel Span Wire (3/8” or 1/4”)	Linear Feet
Pedestrian Pushbutton with Sign	Each
Class 2 Excavation	CY
Audible/Tactile Pedestrian Pushbutton Station & Sign	Each

Signal Heads

Signal heads are paid for per section of standard. They are broken out per the size and type.

Available Items	Unit
Vehicular Traffic Signal Head Section (8” or 12”)	Each
Vehicular Traffic Signal Head Section with Louvers (8” or 12”)	Each
16” LED Pedestrian Signal Head Section	Each
16” LED Countdown Pedestrian Signal Head Section	Each

Detectors

Microloop probes are typically paid per each inclusive of the lead-in cable and three probes. Saw cuts are measured and paid per linear foot. Video detection camera to controller cable is paid per each and is usually in pre-manufactured lengths of 250' or 500' but may also be in increments of 100'.

Available Items	Unit
Microloop Triple Probe Set (500' or 1000' Lead-in Cable)	Each
Non Invasive Microloop Triple Probe Set (500' or 1000' Lead-in Cable)	
Saw Cut for Signal	Linear Feet
Loop Wire Encased in Flexible Tubing (No. 14 AWG)	Linear Feet
Video Detection Camera	Each
Video Detection Camera to Controller Cable (in pre-manufactured lengths	Each

Signal Preemption

Using an optically activated priority control system requires the inclusion of the detector eye, emitter, a discriminator, card rack and cable. The first four items are paid for per each. SHA will typically install three emitters for use with firehouse preemption. The cable is paid for per linear foot from the detector eye to the cabinet. Account for an extra 20% in the length of cable for slack, coil, connections, etc.

When using a hard wire for preemption, a push button shall be installed in the firehouse.

Available Items	Unit
Optically Activated Priority Control System Detector Eye	Each
Optically Activated Priority Control System Detector Emitter	Each
Optically Activated Priority Control System Discriminator	Each
Optically Activated Priority Control System Card Rack	Each
Push Button for Preemption	Each
Optically Activated Priority Control System Detector Cable (4 conductor No. 20 AWG (7x8) stranded cable)	Linear Feet

Signal Removal Items

Remove and Dispose of Foundation 12" Below Grade is only used with Areawide projects.

Available Items	Unit
Remove and Dispose of Existing Signal Equipment	Lump Sum
Remove and Dispose of Foundation 12" Below Grade	Each

Traffic Barrier

Where required to protect roadside hazards, such at sign structures and lamp poles, traffic barrier quantities must be included. There are separate items for the barrier and each type of end treatment.

Available Items	Unit
W-Beam Traffic Barrier	Linear Feet
Traffic Barrier End Treatment	Each
Trail End Anchorage	Each
Surface Adjustment for End Treatments	Cubic Yard
W Beam Barrier Reflective Delineators	Each
Remove Steel Post and Foundation	Each
Remove Existing Traffic Barrier	Linear Feet
Remove Existing End Treatment	Each

Wiring

When estimating cable, use total measured quantity plus 10-20% to account for the excess in handholes, cable slack, connections, splices (loop wire to lead-in only), and drip loops. Remember to include the pole height in the measurements when a pole is used to transport the cable from overhead to underground. For loop wire, include the number of turns per sawcut, plus two times the distance from the detector to the handhole, plus 5% to account for twisted cable.

Available Items	Unit
Signal Wiring	
Electrical Cable, No. 14 AWG (per number of conductors)	Linear Feet
Electrical Cable, 1 Conductor No. 4 or No. 8 AWG	
Electrical Cable, 2 Conductor No. 14 AWG, Aluminum Shielded	Linear Feet
Stranded Bare Copper Ground Wire (No. 4 or 6 AWG)	Linear Feet
12 Pair Communication Cable, Jellyfilled (Underground)	Linear Feet
12 Pair Communication Cable, Self Supporting (Overhead)	Linear Feet
Stranded Bare Copper Ground Wire (#6 or #4 AWG)	Linear Feet
Electrical Cable, 2 Conductor No. 12 AWG Tray Cable	Linear Feet
Lighting Wiring	
Duct Cable (per # conductors and gauge size)	Linear Feet
Electrical Cable (per # conductors and gauge size)	Linear Feet
Stranded Bare Copper Ground Wire (per gauge size)	Linear Feet
Solid Ground Wire (per gauge size)	Linear Feet

Conduit

Conduit is paid for per linear feet and should be calculated by measuring the length plus some extra to account for grading and going around obstacles.

Available Items	Unit
Schedule 80 Rigid PVC Conduit – Trenched (per size)	Linear Feet
Schedule 80 Rigid PVC Conduit – Slotted (per size)	Linear Feet
Schedule 80 Rigid PVC Conduit – Bored (per size)	Linear Feet
1” Electrical Conduit, Galvanized Sleeve	Linear Feet
1” Liquid Tight Flexible Non-Metallic Conduit for Detector Sleeve (per size)	Linear Feet
1” Rigid Steel Conduit	Linear Feet
1” Flexible Steel Conduit	Linear Feet
Galvanized Steel Conduit (per size)	Linear Feet
EMT Conduit (per size)	Linear Feet

Light Structures

Highway lighting has several types of structures. The structures include the pole and bracket arm. The transformer bases and concrete foundations are paid separately.

Available Items	Unit
Concrete for Light Foundation	Cubic Yard
High Mast Light Structure (per pole height)	Each
Light Structure and Bracket Arm (per pole height and arm length)	Each
Aluminum Light Structure and Bracket Arm (per pole height and arm length)	Each
Breakaway Base Support	Each
Lighting arm on Signal Structure (per arm length)	Each

Lamps and Luminaires

Highway and sign lighting has several types of luminaries and lamps. They are paid for together based on the style, type and wattage.

Available Items	Unit
200 Watt High Pressure Sodium Lamp and Luminaire, Rectangular	Each
250 Watt High Pressure Sodium Lamp and Luminaire, Rectangular	Each
400 Watt High Pressure Sodium Lamp and Luminaire, Rectangular	Each
200 Watt High Pressure Sodium Lamp and Luminaire	Each
250 Watt High Pressure Sodium Lamp and Luminaire	Each
400 Watt High Pressure Sodium Lamp and Luminaire	Each
175 Watt Mercury Vapor Lamp and Luminaire	Each
250 Watt Mercury Vapor Lamp and Luminaire	Each
400 Watt Mercury Vapor Lamp and Luminaire	Each
175 Watt Metal Halide Lamp and Luminaire	Each
250 Watt Metal Halide Lamp and Luminaire	Each
400 Watt Metal Halide Lamp and Luminaire	Each

Other Electrical Equipment

In addition to the wiring and conduit there is other electrical equipment that shall be defined. Connector kits for lighting are quantified as a per each item except at intersections. Handholes are commonly used with signals and electrical manholes with lighting design. With any electrical design there will also be a Pole or Base Mounted Cabinet and associated equipment dependent on the power service. Refer to Spec. Sections 807 and 816 for appropriate equipment.

Available Items	Unit
Electrical Handhole	Each
Ground Rod	Each
Electric Manhole	Each
Connector Kit, Type I	Each
Connector Kit, Type II	Each
Connector Kit, Type III	Each
Connector Kit, Type IV	Each
Base Mounted Lighting Cabinet (277/480 V, 3 Phase, 4 Wire)	Each
Base Mounted Lighting Cabinet (120/240 V, 1 Phase, 3 Wire)	Each
Pole Mounted Lighting Cabinet	Each
Embedded Service Pedestal	Each

Miscellaneous

Test pits are used to verify there are no underground utility conflicts with the proposed equipment. For signals and light structures, use one cubic yard for the cabinet and one cubic yard for every two pole foundations.

Sign Lighting Systems are used for overhead structures that encroach on the travel lanes.

Maintenance of Traffic is paid per each for Areawide Contracts and is based on the total estimate amount. Otherwise, it is paid as Lump Sum.

Available Items	Unit
Test Pit Excavation	Cubic Yards
Sign Lighting System	Each
Maintenance of Traffic	Each

Producing the Estimate

Once the final quantities have been determined, the steps required to produce a final estimate vary depending on the type of project. This is due to the different contracting procedures and construction forces available. The primary difference between the different estimate types lies in how the unit prices are determined. In the case of Shop Forces and Areawide projects, all unit prices have been established ahead of time. For Insert and advertised projects, the unit prices must be estimated based on similar projects.

Who Pays for What

Payment provisions for every item in a contract are defined by the Standard Specifications and the Special Provisions. These will tell you what items are paid for, how those items are measured, and what items are incidental to that payment. For each quantity, determine who will supply the appropriate materials to complete the work. This will be determined by current SHA practice and also by the contract type. For example, Signs are SHA supplied on Areawide contracts and Contractor supplied on Insert or Advertised jobs. As mentioned earlier, an estimate should include a separate section tabulating the quantities for all SHA and contractor supplied equipment and materials (this is referred to as the “Equipment List” with sections “A” and “B” respectively).

Shop Forces/Areawide Projects

The unit prices used for Shop Forces and Areawide estimates are usually determined before design of the project has begun. In some instances, a project will require an item for which there is no unit price, and the designer must make a reasonable estimate. These items will then have to be either negotiated with the contractor or purchased and installed separately by SHA. See Appendix A-9 for a detailed description of how to estimate Negotiated and Write-In Items.

On the other hand, if a project requires an item for which there is no unit price, review the existing

items and determine if it makes sense to use another item in its place. For instance, if a 38 foot mast arm is required but doesn't exist in the contract, the designer could call for a 50 foot mast arm (that does have a unit price) and cut the arm to 38 feet.

Due to the diverse nature of Areawide construction, certain items have been customized for this contract and are paid for differently than on other projects. For instance, lighting maintenance systems are usually paid as a separate lump sum item for each overhead/cantilever structure, however, for the Areawide contract they are paid for as the terminal unit plus linear foot of system. It is important to become familiar with the Special Provisions for a contract, where these differences are explained for each contract.

Advertised and Insert Projects

Unit prices for Advertised and Insert projects are calculated from the Price Index using similar projects bid over the previous 12 months. These prices are compiled in a database and made accessible in the MDSHA "Estimator Program". They are applied to the quantities developed in the previous section to estimate the total project cost. On these projects the contractor furnishes all materials and equipment.

Write-In Items

A Write-in item is an item identified in the preliminary design of an Advertised contract that does not have an associated category code number. This item may not have been used by SHA in the past or is very different from what has been used. In these circumstances a Write-in item will be requested and given a category code number of 800000. Accordingly, a Special Provision to the Standard Specifications for Construction and Materials will be developed for that particular contract.

Negotiated Items

A negotiated item is an item specified in the project design that does not exist in an Areawide contract's bid items list. Hence, there is no associated bid price for such items and a unit price must be agreed upon between the State and the Areawide Contractor. Similarly, if there is a need for a new item during construction of an insert project, the item will be added as a redline and a unit price must be agreed upon between the State and the General Contractor.

Under existing Areawide contracts the need for negotiable items shall be determined during preliminary design. The project schedule will be adjusted if necessary, and research for negotiable item vendors, model numbers, costs, etc. shall begin.

At this point a cost estimate to furnish and install the item will be produced. This should include the cost of the items plus a 20% markup and 5% tax. The man-hours and $ rate plus 65% to install shall be included in the estimated price. The equipment hours and $ rate plus 20% shall also be included in the estimate to install the item. Wage rates are provided in the IFB, and the Equipment rates are from the Rental Rate Blue Book.

When negotiable items and cost estimates have been recognized, a prepared memo for the negotiable item to be negotiated shall be submitted to SHA's Traffic Operations Division (TOD). This memo shall include a detailed description of the item, provide specifications, typicals for the work to be completed, and any other pertinent information such as vendors, phone numbers, addresses, etc.

Following this, TOD will contact the Contractor and request a price based on the information provided. The response is to be requested within 3 weeks. The Contractor shall submit a price including a detailed breakdown of cost, labor, tax and profit to complete the work.

If the Contractor's cost is within 10% of the engineers estimated cost, the item shall be approved. If the Contractors cost is more than 10% of the engineers estimate, TEDD shall reevaluate their estimate to determine where the discrepancies are and make the appropriate adjustments as needed.

At this time the Design Engineer shall re-evaluate the PS&E schedule and adjust as necessary. TEDD and TOD will then agree on the price and/or re-negotiate. Once the price has been agreed upon, TOD will set up the item for the remainder of the Contract. TEDD will then PS&E the project to PMO. Note: No project should go to PS&E without approved negotiable items.